

Toxicity Mitigating Single-Fluid Cooling System for Manned Spacecraft, Phase I

Completed Technology Project (2018 - 2019)



Project Introduction

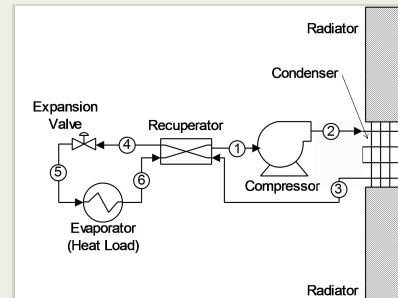
The thermal control systems (TCS) for manned spacecraft are typically two-loop designs where a low freezing point single-phase liquid is used exterior to the manned vessel to reject heat through the radiator array, and a single-phase thermal loop inside the manned vessel that uses a non-toxic liquid is used for payload cooling and space conditioning. As an example, the Orion TCS uses HFE-7200 liquid (-138°C pour point) in the radiators, and PGW in the manned cabin. These loops interface through a shared heat exchanger that is external to the manned vessel to ensure that the working fluid for the external loop cannot leak into the manned cabin. This architecture is necessary for crew safety (most very low freezing point fluids are somewhat toxic or untested) but comes with a mass penalty due to the duplicity of prime movers (pumps), mass of the intermediate heat exchanger, and extra radiator surface area to account for the additional temperature delta required for the intermediate heat exchange process.

The two-loop mass penalty is a driving force toward reducing the TCS to a single working fluid. However, the toxicity risk must be mitigated for this architecture to be realized. Mainstream proposes to replace the two loop TCS architecture with a single loop TCS architecture that has toxicity mitigating technology.

Anticipated Benefits

NASA applications for the proposed toxicity mitigating thermal control system include future Orion-like manned missions and Deep Space Gateway and Transport missions. Any manned space vehicle would benefit from the expected weight and crew safety advantage offered by the innovative thermal control system proposed.

Non-NASA applications for the proposed technology include any manned space vehicle launch for exploration or tourism purposes. The European Space Agency has an aggressive interest in a moon landing in the near future. Additionally, non-government commercial entities such as Space-X, Blue Origin, Bigelow Aerospace, and others include space tourism as a future goal.



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Table of Contents

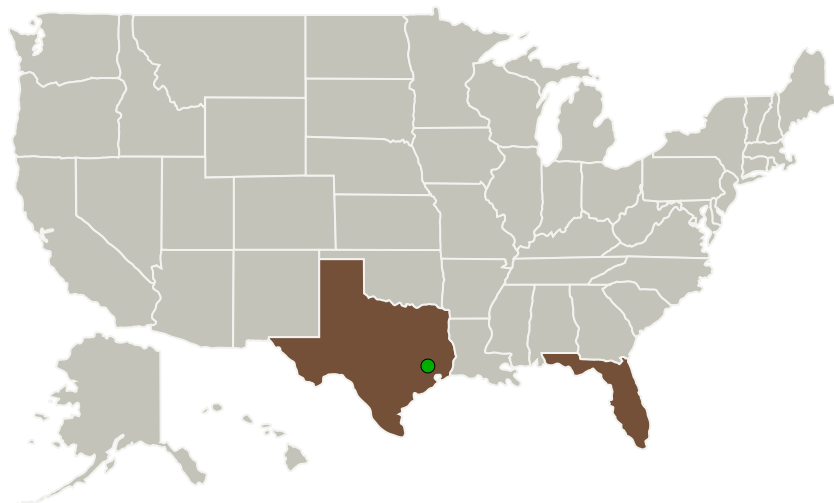
Project Introduction	1
Anticipated Benefits	1
Primary U.S. Work Locations and Key Partners	2
Project Transitions	2
Organizational Responsibility	2
Project Management	2
Technology Maturity (TRL)	2
Images	3
Technology Areas	3
Target Destination	3

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Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Mainstream Engineering Corporation	Lead Organization	Industry	Rockledge, Florida
● Johnson Space Center(JSC)	Supporting Organization	NASA Center	Houston, Texas

Primary U.S. Work Locations	
Florida	Texas

Project Transitions

July 2018: Project Start

February 2019: Closed out

Closeout Documentation:

- Final Summary Chart(<https://techport.nasa.gov/file/139507>)

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Mainstream Engineering Corporation

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

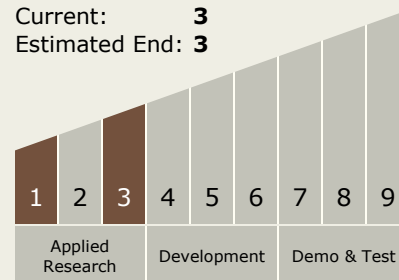
Carlos Torrez

Principal Investigator:

David Sykes

Technology Maturity (TRL)

Start: **1**
Current: **3**
Estimated End: **3**

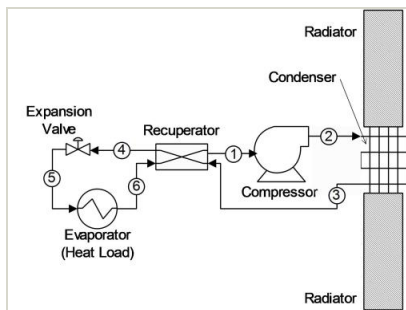


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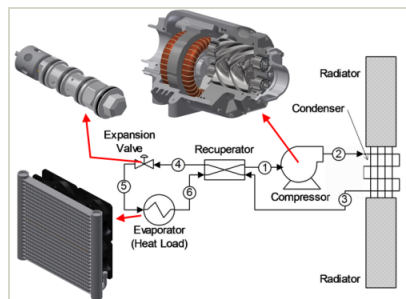
Images



Briefing Chart Image

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(<https://techport.nasa.gov/image/127016>)



Final Summary Chart Image

Toxicity Mitigating Single-Fluid Cooling System for Manned Spacecraft, Phase I

(<https://techport.nasa.gov/image/132688>)

Technology Areas

Primary:

- TX14 Thermal Management Systems
 - └ TX14.2 Thermal Control Components and Systems
 - └ TX14.2.3 Heat Rejection and Storage

Target Destination

Earth